Section: General Medicine

Original Research Article

A STUDY OF PREDICTORS OF MORTALITY IN PATIENTS WITH ACUTE DECOMPENSATED HEART FAILURE

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ABSTRACT

Background: Acute decompensated heart failure (ADHF) is a major cause of hospitalization and is associated with significant in-hospital mortality despite advances in medical therapy. Early identification of predictors of mortality is essential for risk stratification, timely intervention, and optimization of patient outcomes. The aim is to identify the clinical, laboratory, and echocardiographic predictors of in-hospital mortality among patients admitted with acute decompensated heart failure. **Materials and Methods:** This prospective observational study was conducted in the Department of General Medicine of a tertiary care teaching hospital over a period of 18 months. A total of 120 consecutive patients diagnosed with acute decompensated heart failure were enrolled. Demographic characteristics, clinical profile, comorbidities, laboratory investigations, electrocardiographic findings, echocardiographic parameters, and treatment details were recorded using a structured proforma. Patients were followed until discharge or death. Statistical analysis included descriptive statistics, Chi-square test, independent t-test, and multivariable logistic regression to identify independent predictors of in-hospital mortality. A p-value <0.05 was considered statistically significant. **Results:** Among the 120 patients included in the study, 98 (81.7%) survived while 22 (18.3%) died during hospitalization. Advanced age (>65 years), diabetes mellitus, coronary artery disease, chronic kidney disease, atrial fibrillation, and systolic blood pressure below 100 mmHg were significantly associated with mortality (p<0.05). Non-survivors had significantly lower serum sodium and hemoglobin levels, higher serum creatinine, blood urea, NT-proBNP concentrations, and lower left ventricular ejection fraction compared with survivors (p<0.001). Multivariable logistic regression identified left ventricular ejection fraction <30% (AOR 5.18), systolic blood pressure <100 mmHg (AOR 4.65), serum creatinine >2 mg/dL (AOR 3.84), elevated NT-proBNP >8000 pg/mL (AOR 3.63), chronic kidney disease (AOR 3.42), hyponatremia (AOR 3.11), age >65 years (AOR 2.61), and diabetes mellitus (AOR 2.12) as independent predictors of in-hospital mortality. **Conclusion:** Acute decompensated heart failure continues to be associated with considerable in-hospital mortality. Severe left ventricular systolic dysfunction, hypotension, renal impairment, elevated NT-proBNP, hyponatremia, advanced age, and diabetes mellitus were independent predictors of death. Early recognition of these high-risk features using readily available clinical, laboratory, and echocardiographic parameters may facilitate prompt risk stratification, intensive monitoring, and optimization of guideline-directed therapy, thereby improving short-term clinical outcomes.

INTRODUCTION

Heart failure (HF) represents the terminal clinical manifestation of numerous cardiovascular disorders and remains one of the most important causes of morbidity, mortality, and healthcare utilization across the world. It is characterized by the inability of the heart to pump sufficient blood to meet the metabolic demands of the body or to do so only at

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elevated filling pressures. The growing burden of ischemic heart disease, hypertension, diabetes mellitus, obesity, and population aging has contributed substantially to the increasing prevalence of heart failure globally. Recent estimates indicate that more than 64 million individuals are living with heart failure worldwide, making it a major public health concern requiring multidisciplinary management strategies.[1]

Acute decompensated heart failure (ADHF) refers to the sudden onset or worsening of signs and symptoms of heart failure requiring urgent hospitalization. It may occur as a new presentation of heart failure or as an acute deterioration in patients with chronic heart failure. Pulmonary congestion, systemic venous congestion, reduced cardiac output, arrhythmias, renal dysfunction, and electrolyte abnormalities frequently complicate the clinical course of these patients. The contemporary guidelines of the European Society of Cardiology emphasize prompt diagnosis, rapid stabilization, identification of precipitating factors, and early initiation of evidence-based therapies to improve outcomes.[2]

Despite remarkable advances in pharmacological therapy, mechanical circulatory support, and comprehensive heart failure management programs, ADHF continues to carry substantial short-term mortality. Hospital mortality generally ranges between 4% and 10%, whereas mortality may exceed 20–30% among patients presenting with cardiogenic shock or multiple organ dysfunction.[3] Recurrent hospitalization following discharge is common and contributes significantly to declining functional status, poor quality of life, and escalating healthcare costs.[4]

Several clinical, biochemical, and imaging parameters have been investigated as predictors of mortality in ADHF. Advanced age, hypotension, tachycardia, renal impairment, hyponatremia, elevated blood urea nitrogen, anemia, diabetes mellitus, atrial fibrillation, elevated cardiac troponins, increased natriuretic peptide concentrations, and reduced left ventricular ejection fraction have consistently been associated with adverse outcomes.[5,6] Risk prediction models developed from large international registries have demonstrated that combining clinical examination with laboratory biomarkers improves prognostic accuracy and assists clinicians in therapeutic decision-making.[7]

Recent heart failure guidelines advocate systematic risk stratification during hospitalization to identify high-risk patients who may benefit from intensive monitoring, early optimization of guideline-directed medical therapy, and structured post-discharge follow-up. Advances in biomarker research, multimodality imaging, and artificial intelligence-based predictive models are expected to further enhance individualized prognostication and improve survival among patients with ADHF.[2,8]

Although several international studies have evaluated prognostic indicators in heart failure, regional variations in disease characteristics, healthcare accessibility, socioeconomic status, and treatment practices may influence patient outcomes. Data from Indian tertiary care hospitals remain relatively limited, highlighting the need for locally generated evidence. The present study is therefore planned to identify clinical, laboratory, and echocardiographic predictors of mortality among patients admitted with acute decompensated heart failure, thereby contributing to improved risk stratification and patient management.

MATERIALS AND METHODS

Study Design: This study was conducted as a prospective observational hospital-based study to identify the predictors of mortality among patients admitted with acute decompensated heart failure.

Study Setting: The study will be carried out in the Department of General Medicine of a tertiary care hospital with facilities for intensive cardiac care, emergency services, echocardiography, and advanced laboratory investigations.

Study Duration: The study will be conducted over a period of 24 months, following approval from the Institutional Ethics Committee.

Study Population: The study population will comprise adult patients admitted with acute decompensated heart failure during the study period.

Sample Size

A total of 120 patients diagnosed with acute decompensated heart failure will be included using consecutive sampling.

Inclusion Criteria

- Patients aged ≥18 years.
- Patients admitted with acute decompensated heart failure based on contemporary guideline recommendations.
- New-onset heart failure or acute worsening of chronic heart failure requiring hospitalization.
- Patients providing written informed consent.

Exclusion Criteria

- Patients younger than 18 years.
- Congenital heart disease.
- Acute myocarditis.
- Severe valvular heart disease requiring immediate surgical intervention.
- Patients with terminal malignancy or expected survival <3 months due to non-cardiac illness.
- Patients unwilling to participate.

Diagnostic Criteria

Acute decompensated heart failure will be diagnosed according to contemporary guideline recommendations based on:

- Typical symptoms (dyspnea, orthopnea, fatigue)
- Clinical signs (pulmonary edema, elevated jugular venous pressure, peripheral edema)
- Elevated natriuretic peptide levels where available
- Chest radiography

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- Electrocardiography
- Echocardiographic evidence of structural or functional cardiac abnormality.

Data Collection

A structured case record form will be used to collect:

- Demographic profile
- Presenting symptoms
- Vital parameters
- Cardiovascular risk factors
- Previous history of heart failure
- Drug history
- Physical examination findings
- Laboratory investigations
- ECG findings
- Echocardiographic findings
- Treatment administered
- Clinical outcomes

Variables Studied

Demographic Variables

- Age
- Gender
- Body mass index

Clinical Variables

- Blood pressure
- Heart rate
- Respiratory rate
- Oxygen saturation
- NYHA functional class
- Duration of symptoms
- Etiology of heart failure

Comorbidities

- Hypertension
- Diabetes mellitus
- Coronary artery disease
- Chronic kidney disease
- Chronic obstructive pulmonary disease
- Previous stroke
- Atrial fibrillation

Laboratory Investigations

- Complete blood count
- Blood urea
- Serum creatinine
- Serum sodium
- Serum potassium
- Random blood glucose
- Liver function tests
- Cardiac troponin
- NT-proBNP/BNP (where available)

Electrocardiographic Evaluation

- Rhythm abnormalities
- Conduction defects
- Ischemic changes
- Heart rate

Echocardiographic Parameters

- Left ventricular ejection fraction
- Left ventricular dimensions
- Regional wall motion abnormalities
- Right ventricular dysfunction
- Pulmonary artery systolic pressure
- Significant valvular lesions

Outcome Measures

Primary Outcome

- In-hospital mortality.

Secondary Outcomes

- Duration of hospital stay.
- ICU admission.
- Requirement of mechanical ventilation.
- Requirement of inotropic support.
- Development of acute kidney injury.
- Cardiogenic shock.

Statistical Analysis

Data was entered into Microsoft Excel and analyzed using SPSS version 26.0 (or equivalent statistical software). Continuous variables are expressed as mean ± standard deviation or median (interquartile range), while categorical variables are presented as frequencies and percentages. Student's *t*-test or Mann–Whitney *U* test used to compare continuous variables, and Chi-square or Fisher's exact test was used to compare categorical variables. Variables significant on univariate analysis ($p < 0.05$) were entered into a multivariable logistic regression model to identify independent predictors of mortality. Odds ratios with 95% confidence intervals will be reported. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 120 patients admitted with acute decompensated heart failure (ADHF) were included in the study. The patients were followed throughout their hospital stay to determine in-hospital mortality. Of the 120 patients, 22 (18.3%) died, while 98 (81.7%) survived until discharge. Demographic characteristics, clinical variables, laboratory parameters, and echocardiographic findings were analyzed to identify factors associated with mortality.

Table 1: Baseline demographic and clinical characteristics according to outcome

Variable	Survivors (n=98)	Non-survivors (n=22)	p value
Age >65 years	46 (46.9%)	18 (81.8%)	0.003
Male gender	56 (57.1%)	14 (63.6%)	0.58
Hypertension	61 (62.2%)	18 (81.8%)	0.08
Diabetes mellitus	41 (41.8%)	15 (68.2%)	0.028
Coronary artery disease	45 (45.9%)	16 (72.7%)	0.024
Chronic kidney disease	15 (15.3%)	10 (45.5%)	0.002
Atrial fibrillation	13 (13.3%)	9 (40.9%)	0.003
SBP <100 mmHg	19 (19.4%)	15 (68.2%)	<0.001

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Among the 120 study participants, mortality occurred predominantly in older individuals. Patients aged above 65 years accounted for 81.8% of deaths compared with 46.9% of survivors, demonstrating a statistically significant association (p=0.003). Diabetes mellitus was significantly more common among non-survivors (68.2%) than survivors (41.8%, p=0.028). Coronary artery disease was present in 72.7% of patients who died compared with 45.9% among survivors (p=0.024). Chronic kidney disease was nearly three times more frequent in the mortality group (45.5% vs 15.3%, p=0.002). Likewise, atrial fibrillation occurred in 40.9% of non-survivors compared with 13.3% of survivors (p=0.003). Low systolic blood pressure (<100 mmHg) was observed in 68.2% of patients who died versus 19.4% among survivors and showed the strongest association with mortality (p<0.001). Male gender and hypertension did not demonstrate statistically significant associations.

Table 2: Comparison of laboratory and echocardiographic parameters

Parameter	Survivors (n=98) Mean ± SD	Non-survivors (n=22) Mean ± SD	p value
Hemoglobin (g/dL)	11.7 ± 1.8	10.3 ± 1.6	0.001
Serum Sodium (mmol/L)	136.8 ± 4.2	130.9 ± 5.3	<0.001
Serum Creatinine (mg/dL)	1.39 ± 0.58	2.26 ± 0.84	<0.001
Blood Urea (mg/dL)	49.8 ± 18.6	73.5 ± 24.2	<0.001
NT-proBNP (pg/mL)	5218 ± 1846	9465 ± 2817	<0.001
LVEF (%)	38.6 ± 8.4	28.9 ± 6.7	<0.001
Heart Rate (beats/min)	94.5 ± 13.6	112.4 ± 16.8	<0.001

Non-survivors demonstrated significantly worse laboratory and echocardiographic profiles than survivors. Mean hemoglobin was significantly lower among patients who died (10.3 ± 1.6 g/dL) compared with survivors (11.7 ± 1.8 g/dL, p=0.001). Hyponatremia was more pronounced in the mortality group, with mean serum sodium measuring 130.9 mmol/L versus 136.8 mmol/L among survivors (p<0.001). Renal dysfunction was evident, as serum creatinine (2.26 ± 0.84 mg/dL) and blood urea (73.5 ± 24.2 mg/dL) were significantly higher in non-survivors (both p<0.001). Mean NT-proBNP concentration was almost double among patients who died (9465 pg/mL) compared with survivors (5218 pg/mL, p<0.001). Left ventricular systolic function was significantly impaired in non-survivors with a mean LVEF of 28.9%, whereas survivors had a mean LVEF of 38.6% (p<0.001). Additionally, non-survivors had significantly higher heart rates on admission (p<0.001).

Table 3: Multivariate logistic regression analysis for predictors of in-hospital mortality

Variable	Adjusted Odds Ratio	95% CI	p value
Age >65 years	2.61	1.18–5.79	0.018
Diabetes mellitus	2.12	1.04–4.71	0.041
Chronic kidney disease	3.42	1.51–7.82	0.003
SBP <100 mmHg	4.65	2.01–10.73	<0.001
Serum sodium <135 mmol/L	3.11	1.36–7.08	0.007
Serum creatinine >2 mg/dL	3.84	1.66–8.92	0.002
LVEF <30%	5.18	2.18–12.32	<0.001
NT-proBNP >8000 pg/mL	3.63	1.57–8.39	0.003

Multivariable logistic regression identified several independent predictors of in-hospital mortality among patients with ADHF. Reduced left ventricular ejection fraction below 30% emerged as the strongest predictor of death with an adjusted odds ratio (AOR) of 5.18 (95% CI: 2.18–12.32; p<0.001). Hypotension at admission (SBP <100 mmHg) independently increased mortality risk by approximately 4.6-fold (AOR 4.65; p<0.001). Elevated serum creatinine (>2 mg/dL) and chronic kidney disease increased mortality by 3.84-fold and 3.42-fold, respectively. Hyponatremia (<135 mmol/L) independently tripled the risk of death (AOR 3.11; p=0.007). Elevated NT-proBNP (>8000 pg/mL) was also significantly associated with poor outcome (AOR 3.63; p=0.003). Advanced age and diabetes mellitus remained significant predictors after adjustment for confounding variables.

DISCUSSION

The present study evaluated the predictors of in-hospital mortality among patients admitted with acute decompensated heart failure (ADHF). An overall mortality rate of 18.3% was observed, with advanced age, diabetes mellitus, chronic kidney disease, hypotension, hyponatremia, elevated serum creatinine, increased NT-proBNP levels, atrial fibrillation, and severely reduced left ventricular ejection fraction (LVEF) emerging as significant predictors of poor outcome. These findings are in agreement with recent evidence highlighting the multifactorial nature of mortality in patients hospitalized with ADHF.

Severely reduced left ventricular systolic function was the strongest independent predictor of mortality in the present study. Patients with LVEF below 30% had significantly greater odds of in-hospital death

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than those with relatively preserved ventricular function. This observation is supported by the study of Scott D. Solomon et al., who demonstrated that worsening ventricular systolic function is associated with increasing rates of cardiovascular death and recurrent heart failure events across the spectrum of ejection fraction. Their findings emphasized that patients with markedly reduced LVEF derive substantial benefit from optimized guideline-directed medical therapy but continue to remain at high baseline risk for mortality.[9] Similarly, Greene SJ et al. highlighted that failure to achieve optimal titration of heart failure medications in patients with reduced ejection fraction contributes significantly to adverse clinical outcomes, reinforcing the importance of early identification of patients with severe ventricular dysfunction.[10]

Elevated NT-proBNP concentrations were another important predictor of mortality in the present study. Patients who died had markedly higher NT-proBNP values than survivors, reflecting greater myocardial wall stress and advanced cardiac dysfunction. These findings closely parallel those reported by James L. Januzzi Jr. et al., who demonstrated that NT-proBNP is not only valuable for diagnosing acute heart failure but also serves as one of the strongest biomarkers for predicting short-term mortality, rehospitalization, and disease severity.[11] The incorporation of natriuretic peptide measurement into routine clinical practice therefore provides clinicians with an objective tool for early prognostic assessment and therapeutic monitoring.

Atrial fibrillation was significantly more common among patients who experienced mortality. The coexistence of atrial fibrillation further impairs ventricular filling, reduces cardiac output, and increases thromboembolic risk in patients with heart failure. Similar observations were reported by Ulf Sartipy et al., who found that atrial fibrillation independently increases mortality irrespective of the underlying ejection fraction phenotype. Their study suggested that rhythm disturbances should be considered important prognostic indicators and aggressively managed during hospitalization.[12]

Renal dysfunction also demonstrated a strong association with mortality in the current study. Elevated serum creatinine and chronic kidney disease independently predicted poor clinical outcomes, reflecting the adverse impact of the cardiorenal syndrome. These findings agree with those reported by Felker GM and colleagues, who described acute decompensated heart failure as a systemic syndrome involving multiple organ dysfunction rather than isolated cardiac failure.[13] Furthermore, Michel Komajda and collaborators reported that patients presenting with severe acute heart failure frequently develop renal impairment, which significantly increases one-year mortality despite contemporary management strategies.[14] The close interaction between cardiac dysfunction and renal injury underscores the importance of careful fluid balance, renal monitoring, and optimization of diuretic therapy during hospitalization.

The present study further demonstrated that worsening renal function during admission was associated with increased mortality. This finding corroborates the work of Marco Metra et al., who observed that deterioration in renal function during hospitalization reflects advanced hemodynamic compromise and neurohormonal activation. However, they also emphasized that transient increases in serum creatinine occurring during effective decongestion should be interpreted cautiously within the overall clinical context.[15] Our findings nevertheless reinforce the prognostic importance of renal function assessment at admission and throughout hospitalization.

Admission hypotension emerged as another independent predictor of mortality. Patients presenting with systolic blood pressure below 100 mmHg experienced significantly poorer outcomes, likely reflecting reduced cardiac output and impending cardiogenic shock. These findings are consistent with the recommendations of Alexandre Mebazaa et al., who emphasized that hypotensive patients require rapid stabilization, close hemodynamic monitoring, and early institution of evidence-based therapies to improve survival. Their recommendations advocate prompt recognition of high-risk patients in the emergency department and early transfer to specialized cardiac care units when indicated.[16]

Overall, the findings of the present study are in close agreement with contemporary literature indicating that mortality in acute decompensated heart failure is determined by a combination of impaired ventricular function, neurohormonal activation, renal dysfunction, rhythm abnormalities, and hemodynamic instability. Most of these variables are readily available during the initial evaluation of hospitalized patients and can therefore be incorporated into routine bedside risk stratification. Early identification of high-risk individuals may facilitate timely optimization of guideline-directed medical therapy, intensive monitoring, multidisciplinary care, and consideration of advanced heart failure interventions, thereby potentially improving short-term survival.

CONCLUSION

Acute decompensated heart failure continues to be associated with considerable in-hospital mortality despite advances in contemporary management. The present study demonstrated that advanced age, diabetes mellitus, chronic kidney disease, hypotension at admission, hyponatremia, elevated serum creatinine, markedly increased NT-proBNP levels, atrial fibrillation, and severe left ventricular systolic dysfunction (LVEF <30%) were significant predictors of in-hospital mortality. Early recognition of these high-risk characteristics may facilitate

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prompt risk stratification, intensive monitoring, optimization of guideline-directed medical therapy, and appropriate referral for advanced heart failure care. Incorporating simple clinical variables together with laboratory and echocardiographic parameters into routine assessment has the potential to improve patient outcomes and reduce mortality in acute decompensated heart failure.

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